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TECHNIQUES AND MACHINING PROCESSES USED IN THE MANUFACTURE OF COMPONENTS FOR HIGH ALTITUDE MASS SPECTROMETERS

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Scientific Report No. 1

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Cutter Relief Angle	Taps
High Speed Steel Drills	Parts
Water - Soluble Oil	Mass Spectrometer
Stress Relieving	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Fabrication techniques described in this report reflect on time saving methods and improved machining for several components used in High Altitude Mass Spectrometers.

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LIST OF ILLUSTRATIONS

LIST OF CONTRIBUTORS

The following individuals have contributed in various phases to this report:

Martin McDonald, Sr. Designer

Amy Gaiennie, Secretary

Techniques and Machining Processes Used in the Manufacture of Components for High Altitude Mass Spectrometers

1.0 INTRODUCTION

Mass spectrometers have for some time been used to an increasing degree for the investigation of the upper atmosphere. These instruments, mounted in high altitude research rockets, must be capable of operating at very low pressures on the order of magnitude of 10^{-8} Torr or lower. They must be capable of surviving various vibrational shake tests without any impairment of their design function. This requires proper component design for structural integrity, and good machining proceedures and methods regarding mating parts, parallelism, squareness and surface finishes.

2.0 DESCRIPTION

The first tasks emanated from design modifications requirements for a nitrogen and a helium pumped multiplier housing assembly units. New design and mechanical detail drawings were generated to incorporate a flange design that allowed the elimination of a welding operation.

2.1 Filament Holder Ion Source - LKD73-79B

These filament holders were manufactured from both 304 Stainless steel and commercially pure titanium.

Milling procedures used were the same for both materials. High speed steel tools were used, as they have the highest toughness and are more resistant to failure by chipping than carbide tools, particularly in the use of titanium. In the milling of titanium parts, it is absolutely essential to have sharp cutters, with the smallest diameter and largest number of teeth or flutes to minimize chatter and deflection. It was found advantageous to increase the relief angle over that used on a standard cutter by about 30%. This reduced the pressure and loading on the tool. It was found that high speed steel drills worked suitably well after the point was ground blunt to about a 140° angle. Water-soluble oil was used as a coolant for all machining.

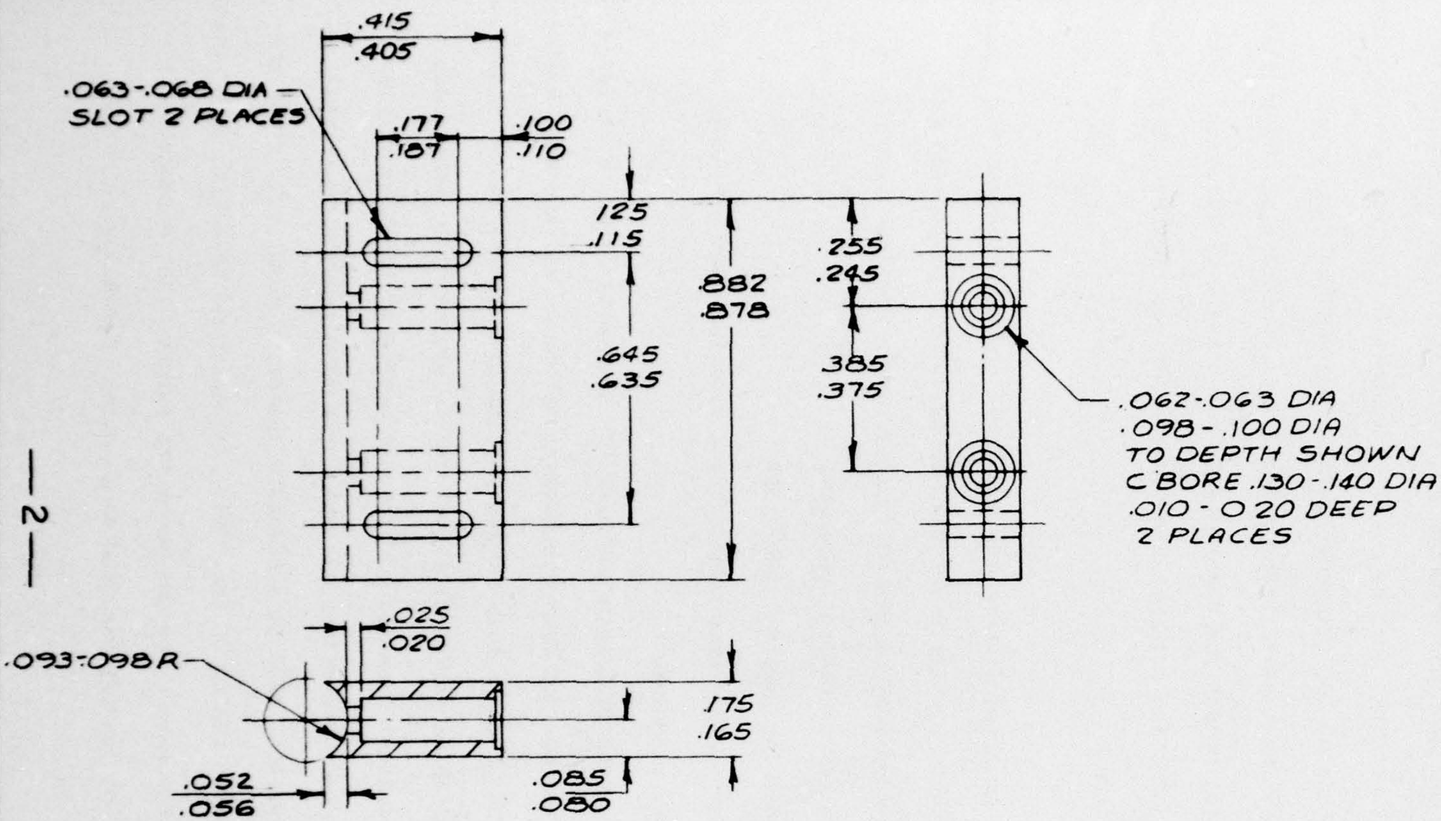


FIG I

DRAWING REVISED AND REDRAWN 11-19-75

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±0°30'

MATERIAL: 304 SST

TREATMENT:

FINISH: 32

DRAFTSMAN: M. McDonald DATE: 11-19-75

CHECKER:

ENGINEER:

RELEASED:

PROD. APPD.:

NAME: FILAMENT HOLDER ION SOURCE

SCALE: 4 X 1 WT.:

AIR FORCE CAMBRIDGE RESEARCH LAB
L. G. HANSCOM FIELD
BEDFORD, MASS.

DRAWING NO.: LKD73-79B

Regarding the elongated slots on the filament holders (Figure 1), in both the stainless steel and titanium pieces, a high speed steel end mill was originally used, but due to the tenacity of the materials, excessive wear and dulling of the cutting tool occurred.

An alternate method of machining slots proved more successful. An electric discharge machine with an electrode of brass and one of graphite was used. It was found the graphite electrode gave much faster cutting action.

2.2 Electrode Assembly (Switched Ion Neutral)

The electrode assembly is a component of the Ion Source Assembly, and is mounted on top of the housing of the switched ion neutral units. A cross section of this part is shown in Figure 2A.

The machining process required generating sloping surfaces on front and back sides with a resulting cross sectional thickness of .015. In order to achieve this cross section and maintain the required parallelism and straightness, much time was required.

Another method was devised that eliminated one machining operation and the problem of holding straight and parallel sides.

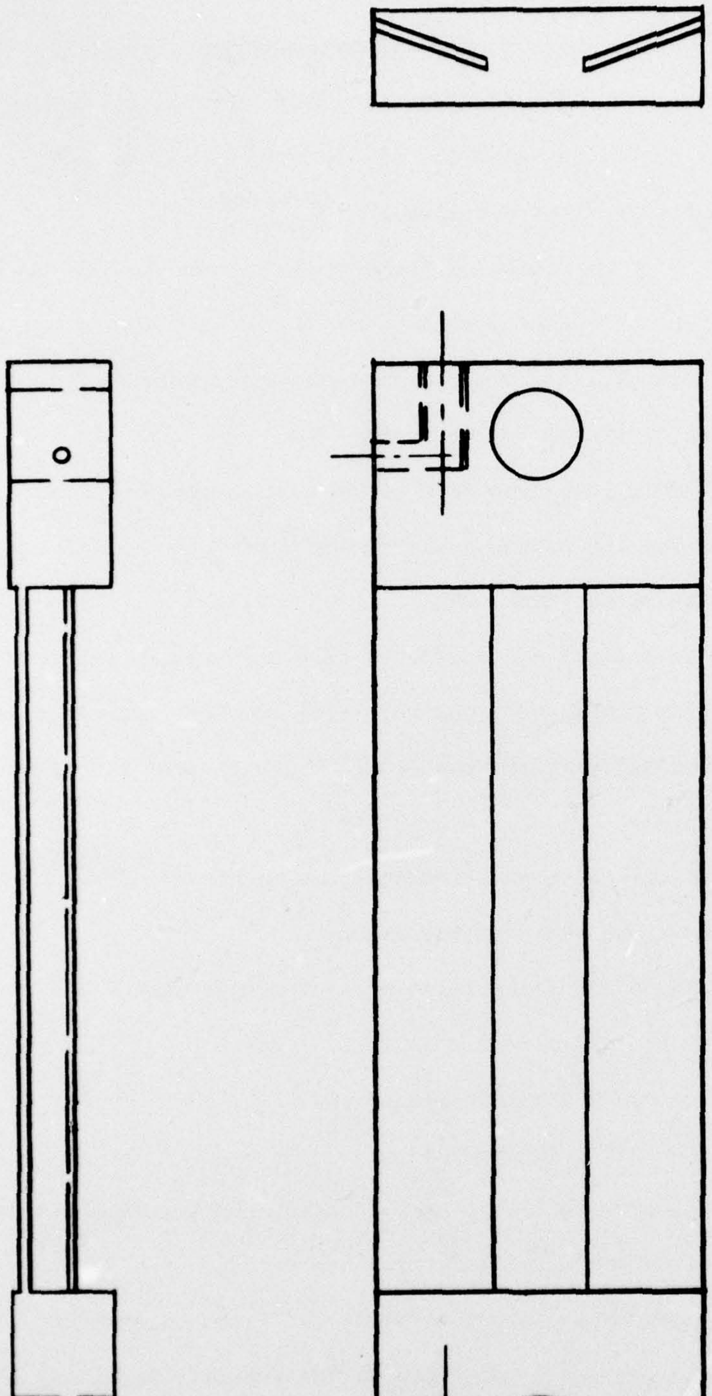
The back side was done with a ball end mill of proper size. The function of the part was unchanged by this method.

A cross-sectional view is shown in Figure 2B.

2.3 Filament Electrode - No. 1 Ion Source

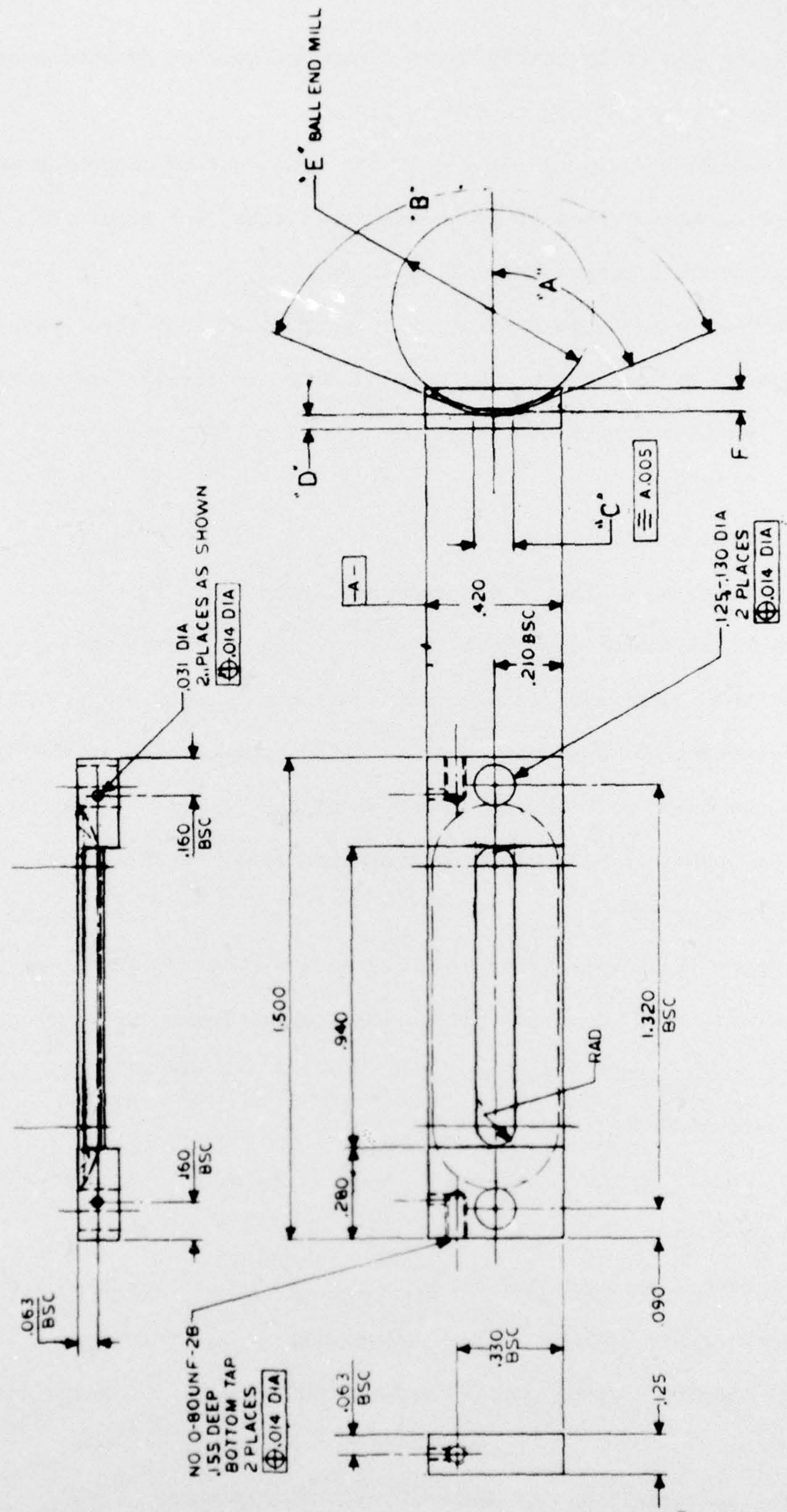
Manufacturing proceedures were the same as described for filament holder ion source page 1, including the milling cutters and drills.

In the area of tapped holes in titanium, it was found to be more easily tapped, with galling, seizing and tap breakage reduced by cutting a 65% thread rather than the conventional 75%. It is also possible to improve the tapping procedure by grinding a heavy chamfer on the trailing edge of the tap, leaving a small portion of land on the cutting edge. This prevents rubbing between tap and work.



ELECTRODE ASSEMBLY

FIG. 2A



"E" BALL END MILL
"B"
"A"
"D"
F
"C"
A.005
-A-
.420
.210 BSC
.125-.130 DIA
2 PLACES
.014 DIA
.031 DIA
2 PLACES AS SHOWN
.014 DIA
.160
BSC
1.500
.940
RAD
1.320
BSC
.280
.160
BSC
.063
BSC
.090
.330
BSC
.125
.063
BSC
NO 0-80UNF-2B
.155 DEEP
BOTTOM TAP
2 PLACES
.014 DIA

FIG 2B

If the hole to be tapped shows a sign of burning or roughness, the possibility of breaking of the tap is high.

Non-sulfo-chlorinated oils or paste type cutting compounds may be used.

(For pictorial view of above described item, see Figure 3).

2.4 Quadrupole Housing (SW-I-N) LKD73-82C

Previous quadrupole housings were fabricated from three pieces, with flanges welded on each end of the housing body, requiring four operations:

1. Machine pieces oversize
2. Welding
3. Stress relieving
4. Final machining to desired dimensions

Due to alignment and close tolerances required with mating parts, control of the squareness, parallelism and concentricity was possible to a much higher degree of accuracy by eliminating operations 1, 2 and 3, and machining the quadrupole housing from one piece.

(For pictorial view of above described item, see Figure 4).

2.5 Quadrupole Rods

Originally 5/16 diameter 304 S.S. Rods were used and turned down to .255 diameter. They were then stress relieved to remove stresses introduced by turning operations. Holes were then drilled and tapped as required, and the rods were then centerless ground.

To reduce the time involved in making the rods, .253 diameter 304 S.S. rods were purchased, which is a standard item.

The pieces were then machined to desired length, drilled and tapped, and then centerless ground, thereby eliminating rough turning and grinding.

All quadrupole rods done by this method have proved satisfactory in all respects.

(For pictorial view of above parts, see Figure 5).

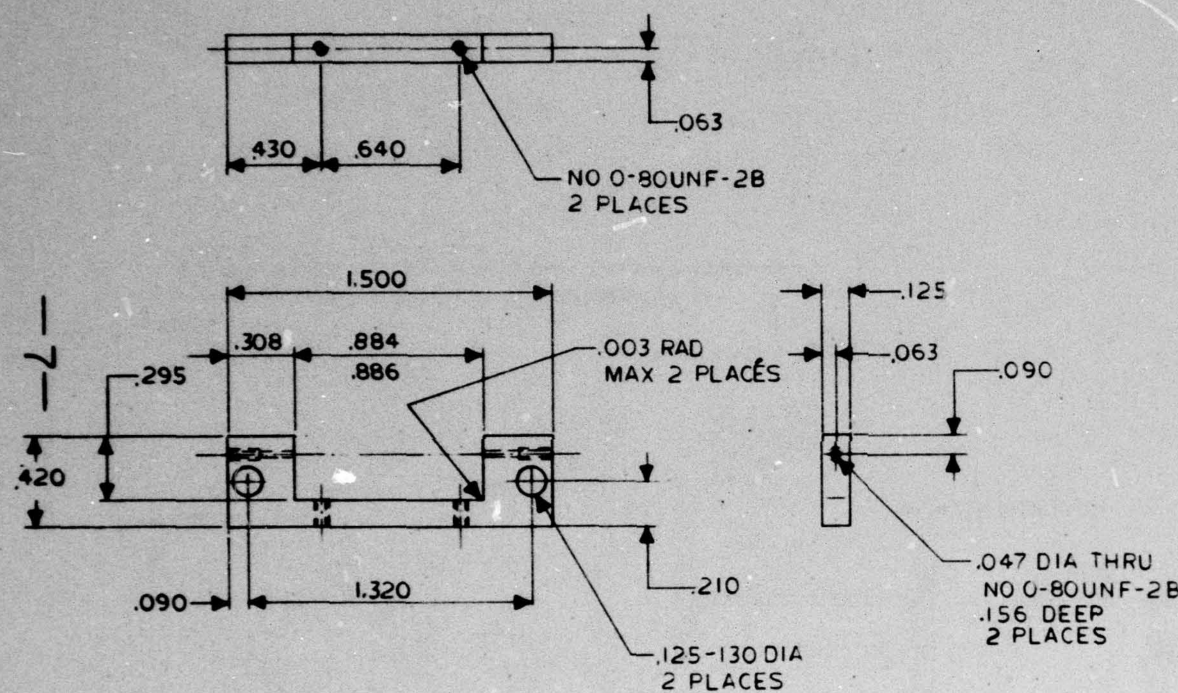
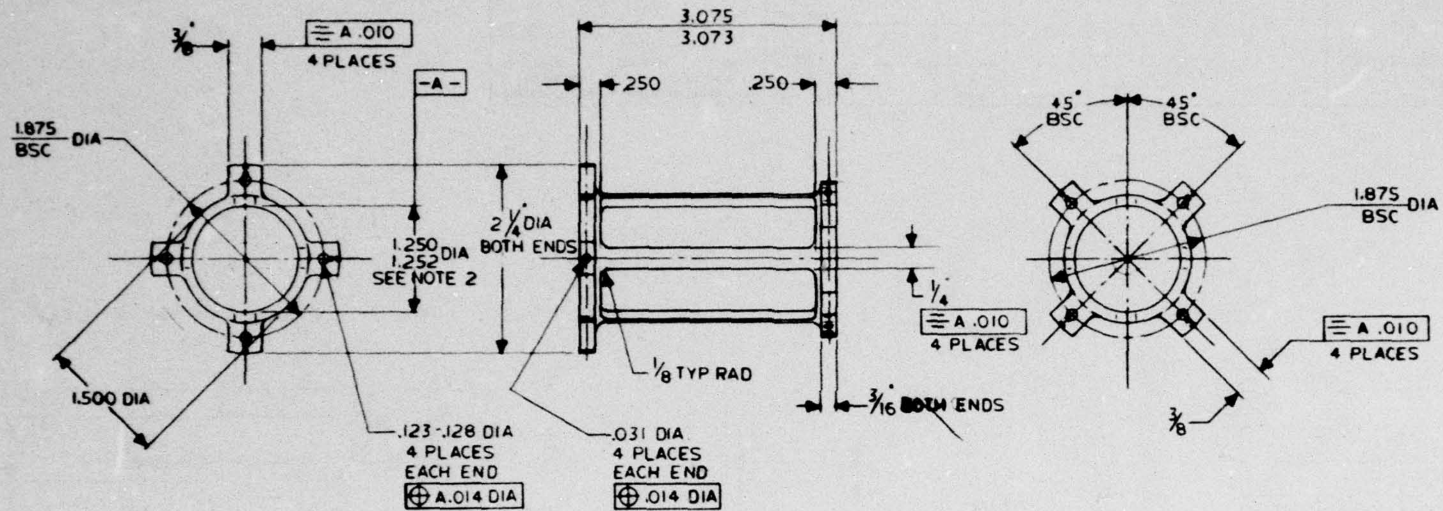


FIG 3

PART NO	MATERIAL
-1	304 SST
-2	TITANIUM

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON FRACTIONS DECIMALS ANGLES ±.005	DRAFTSMAN M. McDonald	DATE 10-2-73	NAME FILAMENT ELECTRODE #1 ION SOURCE 5/8 FILAMENT	AIR FORCE CAMBRIDGE RESEARCH LAB L. G. HANSCOM FIELD BEDFORD, MASS.
MATERIAL SEE CHART	CHECKER			
TREATMENT	ENGINEER			
	RELEASED			
FINISH 16 F.A.O.	PROD. APPD.		SCALE 2 X 1 WT.	LKD-73-80B DRAWING NO.



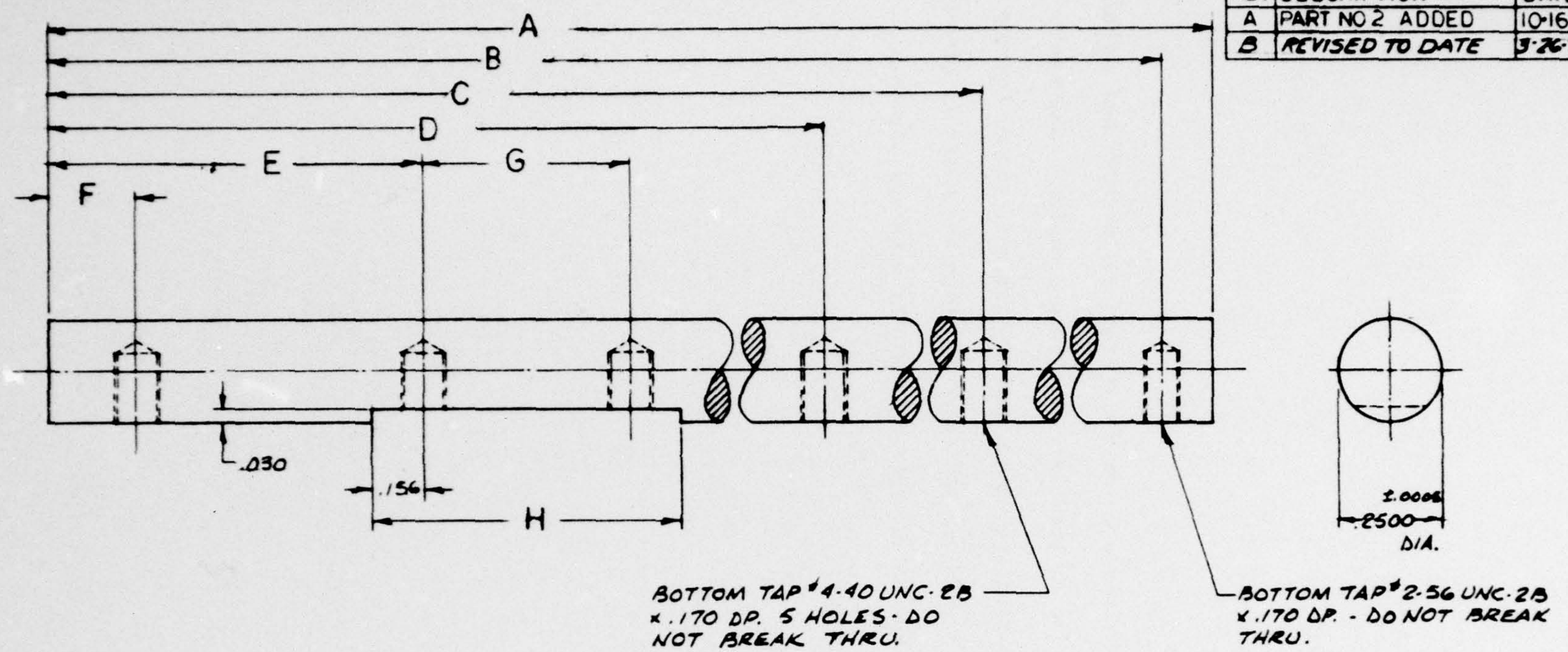
NOTES

1. REMOVE ALL BURRS AND BREAK SHARP EDGES .005 MAX
2. DIM REQUIRED OVER .250 LENGTH EACH END ONLY REMAINDER TO BE 1.250 - 1.260 DIA.

FIG.4

± 1/64 ± .005 ± .5°			QUADRUPOLE HOUSING SW-1-N	AIR FORCE CAMBRIDGE RESEARCH LAB L. G. HANSCOM FIELD BEDFORD, MASS.
316 SST				
EXCEPT AS NOTED			1 X 1	LKD-73-82 C

REV	DESCRIPTION	DATE
A	PART NO 2 ADDED	10-16-73
B	REVISED TO DATE	3-26-73



NOTES:

1. TH'D. HOLES ARE TO BE MADE PRIOR CENTERLESS GRINDING.
2. STRESS RELIEVE AT 675° F. FOR 2 HOURS, SUPPORTED AT ONE END ONLY BEFORE GRINDING.
3. FINISHED ROD TO BE STRAIGHT END TO END WITHIN .001 T.I.R.
4. TH'D. HOLES TO BE COPLANAR.

PART NO	A ±.001	B ±.001	C ±.001	D ±.001	E ±.020	F ±.001	G ±.020	H ±.005
-1 (RCA MULTIPLIER)	9.815	9.690	6.970	3.590	.860	.210	.500	.873
-2 (J L MULTIPLIER)	11.383	11.258	8.538	5.158	2.428	1.778	.500	.873
-3 (J L MULTIPLIER)	11.383	11.258	8.538	5.158	2.428	1.778	1.250	1.563
-4 (RCA MULTIPLIER)	9.815	9.690	6.970	3.590	.860	.210	1.250	1.563

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON FRACTIONS ±1/64, DECIMALS ±.005, ANGLES ±1/2°	DRAFTSMAN AFR, DATE 11-21-73	NAME: QUADRUPOLE ROD HELIUM INST. CONE	AIR FORCE CAMBRIDGE RESEARCH LAB, L. G. HANSCOM FIELD, BEDFORD, MASS.
MATERIAL: 316 ST'LESS ST'L. 5/16 DIA.	CHECKER		
TREATMENT	ENGINEER		
FINISH: 16 FAO	PROD. APPD.	SCALE 4" = 1", WT.	DRAWING NO. LKD 73-75-B

- FIG. 5 -

3.0 CONCLUSION

The above report describes some of the operations, methods and techniques used in the machine processing of stainless steel and titanium. Costs were significantly reduced by eliminating unnecessary operations, and by the use of the electric discharge machine in generating small holes and slots in less time and eliminating the use of end mills where dulling and breakage of these resulted, due to their small size.